

### Method for producing a rim hole

The invention refers to a method for producing a rim hole through a pile of at least two plate-shaped work pieces and in which, by means of a rim hole punch basically driven through the pile vertically, material of one plate-shaped work piece facing the rim hole punch is pulled through an opening of the other plate-shaped work piece, whereby the inner contours of the opening basically correspond to the outer contours of the rim hole.

Such methods for producing a rim hole are known from the state of the art. For example, in DE 89 03 243 a piercing is disclosed that connects several machined parts lying on top of each other without a rivet. The machined parts are in that case each provided in a preceding work step with round holes. In doing so, the hole of a machined part lying on the outside is smaller than the holes of the other machined parts. For forming a rim hole, the edge area of the smaller hole of the machined part on the outside that covers the larger holes of the other machined parts is pressed through the holes of the other machined parts. This rim hole protrudes over the outside surface of the other machined part lying on the outside and is subsequently flanged.

A method of the type cited above as a method for joining plates is also known from DE 40 35 210 A1. In the latter, the plates to be connected are likewise punched individually in a previous work step. The plate constituting the rim hole is left unpunched. A rim hole is produced by pressing a clipping punch through work pieces piled against a pressure plate, whereby the material of the unpunched plate is pulled through the pre-drilled holes of the other plates and opens out on the other side of the plates.

In the supplemental application DE 42 02 279 A1 accompanying DE 40 35 210 A1 quoted above, a block punch is additionally used which flanges the spread-outs and thus creates a tight connection.

A disadvantage with known methods is that the machined parts or plates to be

connected must be pre-drilled individually in a separate work step. When drilling is accomplished, a decision must be made whether the machined part or plate in question forms the rim hole, in which case a small drill hole or no drill hole is made, or whether the rim hole is pressed through the machined part or plate in question, in which case larger holes must be made. Such a method is unprofitable due to the extra work steps and due to the different drill holes of the machined parts or plates, depending on intended usage it is cumbersome and prone to error.

In order for the drill holes separately produced in each plate to meet up exactly to produce the rim hole, the sum tolerance of the drill hole position must be kept precisely. For this, however, expensive machinery and trained personnel are required.

It is thus the object of the present invention to reduce the number of work steps in the method for producing a riveted joint, to simplify the various work steps and thus to make the method more profitable.

According to the present invention, the object for a method of the above-mentioned type is solved by having formed in a single feed movement of the rim hole punch both the rim hole as well as the opening on the other rear plate-shaped work piece, seen from the direction of feed of the rim hole punch, by supporting the plate-shaped work piece pointing away from the rim hole punch by a matrix so that when the rim hole punch is driven into the pile from the rear plate-shaped work piece a piece of material is broken out whose outer contours basically correspond to the outer contours of the rim hole.

This solution is simple. Surprisingly, the production of holes of different sizes on the work piece facing the rim hole punch and on the rear work piece (or rear work pieces) can be waived by having - when producing the rim hole - a piece (or pieces) of material broken out of the rear work piece (or work pieces) thus producing an opening that the rim hole largely fits into with its contours. Drilling the holes individually into the work pieces can thus be dispensed with, manufacturing costs of

the process constituting the invention are thus lower than with current state-of-the-art processes, the process is simpler and less prone to error. The process is applicable to any cross-section shapes of the rim hole desired. Of particular practical importance are rim holes with circular cross-section and rim holes in the shape of oblong holes.

In addition, the process for producing the rim hole is made considerably simpler and cheaper because the inventor has, contrary to expectations, succeeded in additionally producing the rim hole simultaneously with the piece of material to be broken out in the course of a single feed movement of the rim hole punch through the pile supported by the matrix.

In an advantageous embodiment, at the end of the rim hole punch feed movement the rim hole can protrude over the rear plate-shaped work piece surface facing the matrix. This makes sense especially if a maximum length of the rim hole is desirable, e.g. as in cutting a thread in the rim hole. In this way too, the rim hole can be processed in additional subsequent process stages.

In an advantageous manner the rim hole protruding over the rear plate-shaped work piece surface facing the matrix is preferably flanged for producing a rim hole riveting by means of a flanging punch applied from a side opposite the work piece, in which case after flanging the outer surfaces of the rim hole at least in certain sections rest on the outer surface of the rear work piece.

In an advantageous embodiment of the invention, prior to formation of the rim hole, a penetration opening can be created through the pile whose cross-section surface corresponds at most to the cross-section surface of the rim hole opening. Such a penetration opening produces a particularly clean rim hole since the rim hole punch is centred and led through the penetration opening. In addition, the rim hole in this embodiment contains less material so that due to less pronounced plastic distortion the rim hole does not break through in places of maximum plastic distortion.

In a further embodiment of the invention, provision can be made for having the penetration opening through the pile produced with an essentially constant cross-section. This facilitates particularly rapid and inexpensive production of the penetration opening.

The number of work steps is reduced optimally by having, in a further advantageous embodiment, the penetration opening produced by the rim hole punch with the feed movement of the rim hole punch while the rim hole and the piece of material are simultaneously formed. Since with this embodiment penetration opening, rim hole and piece of material are produced in a single feed movement of the rim hole punch, production times and manufacturing costs can in this way be drastically reduced.

Here below, two embodiments of the process constituting the invention are described on the basis of drawings by way of example.

The expert is encouraged at this point to determine which non-inventive sub-combinations of features described in the embodiments solve the objective task of achieving the goal of the invention at each stage according to the respective and most obvious state of the art.

Fig 1 shows a first step of a first embodiment of the method constituting the invention for producing a riveted joint.

Fig 2 shows a second step of the first embodiment of the method for producing a riveted joint.

Fig 3 shows a third step of the first embodiment of the method constituting the invention for producing a riveted joint.

Fig 4 shows a fourth step of the first embodiment of the method constituting the invention for producing a riveted joint.

Fig 5 shows a fifth step of the first embodiment of the method constituting the invention for producing a riveted joint.

Fig 6 shows the finished riveted joint as produced by the first embodiment of the method constituting the invention for producing a riveted joint.

Fig 7 shows a first step of the second embodiment of the method constituting the invention for producing a riveted joint.

Fig 8 shows a second step of the second embodiment of the method constituting the invention for producing a riveted joint.

Fig 9 shows a third step of the second embodiment of the method constituting the invention for producing a riveted joint.

Fig 10 shows a fourth step of the second embodiment of the method constituting the invention for producing a riveted joint.

Fig 11 shows a fifth step of the second embodiment of the method constituting the invention for producing a riveted joint.

Fig 12 shows the finished riveted joint as produced according to the second embodiment.

Here below, the first embodiment will be explained on the basis of the schematic figures 1 through 6 showing in each case the work pieces and tools in cross-section.

Fig 1 shows plate-shaped work pieces 1 and 2, of different thickness, piled on top of each other and which are to be joined.

Fig 2 shows how a penetration drilling 3 through work pieces 1, 2 is accomplished by

means of a drill 4 through vertical feed through the pile composed of work pieces 1 and 2. The diameter of the penetration drilling 3 in this embodiment example is constant throughout. Work pieces 1 and 2 are made of steel but can consist, independently from each other, of different metal materials.

In Fig 3, the dynamically balanced rim hole punch 7 is shown consisting of several sections 7a, 7b, 7c and 7d and fed through penetration drilling 3. The phase 7d at the front end of the rim hole punch 7 serves for more easily driving the rim hole punch 7 into the penetration drilling 3. The connecting centring piece 7c centres the rim hole punch 7 in the penetration opening 3. The shaft section 7a has an external diameter corresponding to the internal diameter of the completed riveted joint. This diameter is larger than that of the penetration opening 3. The transition section 7d of the rim hole punch 7 lies between the centring piece 7c and the shaft section 7a. The rim hole punch 7 is fed vertically to work pieces 1 and 2 coaxially to the penetration drilling.

Simultaneously, the dynamically balanced matrix 8 on the opposite side of the pile from rim hole punch 7 is fed such that it supports work piece 2 in the outer range of the circular groove 4.

Fig 4 shows the end of the feed movement of the rim hole punch 7 through work pieces 1 and 2. A piece of material 10 has broken out of work piece 2 and the rim hole 9 formed by work piece 1 extends through the opening thus created (21) in work piece 2. The internal diameter of the rim hole 9 corresponds to the external diameter of the shaft section 7a. The matrix 8 thereby supports work piece 2.

If only one rim hole 9 is to be produced, then the process ends with this step.

After finishing rim hole 9 that is created during the rim hole punch's (7) feed movement shown in Figs 3 and 4, the rim hole 7 is flanged, as is shown in Fig 5. For this, a dynamically balanced flange punch 12 is fed from the side of work piece 2 along the centre line 6 while simultaneously a pressure plate 13 supports the pile on the side of work piece 1. The flange punch 12 has a shape corresponding to the

finished riveted joint. In doing so, the flanged rim hole 9 rests with its outside surface 14 on outer surface 15 of work piece 2.

This is shown a second time in Fig 6 where the finished dynamically balanced riveted joint with the circular shaped opening 50 of the rim hole is shown. Work pieces 1 and 2 are tightly connected to each other by the flanged rim hole 9.

Here below, a second embodiment of the method constituting the invention for producing a rim hole riveting in the shape of an oblong hole is described on the basis of Figs 8 through 12. In doing so, only the differences in relation to the first embodiment will be dealt with in detail. Corresponding parts and devices of the second embodiment bear the same reference symbols as those of the first embodiment. Figs 8 through 12 show the process stages schematically in cross-section.

Fig 7 corresponds to Fig 1, work pieces 1 and 2 are, nonetheless, made of aluminium in the second embodiment.

In Fig 8, a rim hole punch 7 is shown that has been modified contrary to the first embodiment and that is led through work pieces not drilled in this embodiment. Instead of phase 7d, the rim hole punch has a punched section 7e. The punched section 7e produces, during the rim hole punch's (7) feed movement, the penetration opening 3' in an oblong hole shape. The penetration opening 3' serves to prevent the accumulation of too much material in the rim hole 9. If too much material is actually in rim hole 9, then the material must flow particularly strongly. This generally results in a breakthrough of the rim hole and in riveted joints with reduced resistance to strains. During feed with rim hole punch 7, work piece 2 is supported by matrix 8. However, it is also feasible that during production of penetration opening 3', work piece 2 is supported by a smaller matrix located inside matrix 8, so that the edges of the penetration opening 3' break off clean. In this case, the internal diameter of this smaller matrix corresponds approximately to the diameter of penetration opening 3'. The punch cross-section 7e has the shape of an oblong hole as does as well the

cross-section of shaft section 7a and transition section 7d.

In Fig 9, a condition is shown in which the penetration opening 3' has just been created by punch section 7e and in which the centering piece 7c is located in the penetration opening 3'. For producing the penetration opening 3', two further pieces of material (16 and 17) have been created. The piece of material 17 was broken out of work piece 2, the piece of material 16 was broken out of work piece 1 through the punch section 7e of the rim hole punch 7. Matrix 8 supports work piece 2 similarly as in the first embodiment example. In order for matrix 8 to support work piece 2 optimally, its shape corresponds likewise to the shape of an oblong hole.

Fig 10 corresponds to Fig 4 of the first embodiment, Fig 11 likewise corresponding to Fig 5 of the first embodiment.

Fig 12 shows that in the second embodiment in the cross-section the same type of riveted joint is created as in the first embodiment. But the riveted joint nevertheless here has the shape of an oblong hole 51.